ROY-CAMILLE TECHNIQUE FOR LATERAL MASS FIXATION IN CERVICAL SPINE FACETAL JOINT DISLOCATION
– A SHORT TERM OUTCOME ANALYSIS

Dissertation Submitted For

M.S. DEGREE EXAMINATION

Branch – II – ORTHOPAEDIC SURGERY

DEPARTMENT OF ORTHOPAEDIC SURGERY

MADRAS MEDICAL COLLEGE, CHENNAI – 3

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI

MARCH 2009

CERTIFICATE

*This is to certify that this dissertation entitled **"ROY-CAMILLE TECHNIQUE FOR LATERAL MASS FIXATION IN CERVICAL SPINE FACETAL JOINT DISLOCATIONS - A SHORT TERM OUT COME ANALYSIS"** submitted by **Dr.A.P.SIVAKUMAR** appearing for Part II, M.S. Branch II – Orthopaedic Surgery degree examination in March 2009 is a bonafide record of work done by him under my direct guidance and supervision in partial fulfillment of regulations of The Tamil Nadu Dr.M.G.R. Medical University, Chennai.*

I forward this to The Tamil Nadu Dr.M.G.R. Medical University, Chennai, Tamil Nadu, India.

Padma Laureate Prof. MAYILVAHANAN NATARAJAN,
M.S.Orth.(Ma's), M.Ch. Orth.(L'pool), Ph.D. (Orth Onc)., D.Sc., D.Sc.(Hon), D. Sc. (Hon)
professor and Head, Department of Orthopaedic Surgery,
Madras Medical College and
Government General Hospital
Chennai – 600003

Prof. T.P KALANITI M.D.,
Dean,
Madras Medical College
Government General Hospital,
Chennai – 600 003.

ACKNOWLEDGEMENT

I express my thanks and gratitude to our respected Dean ***Prof.T.P. KALANITI, M.D.,*** *Madras Medical College, Chennai-3 for having given permission for conducting this study and utilise the clinical materials of this hospital.*

I have great pleasure in thanking my teacher and guide ***Padma Laureate Prof. MAYILVAHANAN NATARAJAN, M.S.Orth (Ma's), M.Ch., Trauma(L'PooI), Ph.D, (Orth Onco) D.Sc., F.A, M.S., D.Sc(Hon)*** *Professor & Head, Department of Orthopaedic Surgery, Madras Medical College, Chennai for his valuable advice and guidance.*

My sincere thanks and gratitude to **Dr. R.H.GOVARDHAN, *M.S.Orth, D.Orth,,*** *Addl. Professor in Orthopaedic surgery, for constant advice and supported provided throughout this study.*

My sincere thanks and gratitude to **Dr. V. THULASIRAMAN *J.S.Orth., D.Orth.,*** *Addl. Professor in Ortrhopaedic surgery, for his valuable advice and support throughout the study.*

My sincere thanks and gratitude to **Dr. S.SUBBIAH *M.S.Orth., D.Orth.,*** *Addl. Professor in Ortrhopaedic surgery, for his valuable advice and support.*

I am very much grateful to **Dr. R. SELVARAJ, *M.S.Orth., D.N.B. Ortho.,*** *for his unrestricted help and advice throughout the study period.*

I am very much grateful to ***Dr. R. SUBBIAH, M.S.Orth., D.Orth.,*** *Associate Professor in Ortrhopaedic spine surgery, for his unrestricted help and advice throughout the study period.*

I sincerely thank ***Dr. NALLI R UVARAJ M.S.Orth., D.Orth.,*** *Associate Professor in Ortrhopaedic spine surgery, for his advice and guidance.*

I sincerely thank ***Dr. T.R. Ramesh Pandiyan, Dr.V.Mazhavan, Dr.Pasupathy, Dr.N.B.Thnnmaran, Dr.Velmurugan, Dr.Karunakaran, DrAntony Vimalraj, Dr.Manimaran, Dr.Shanmuga Sundaram, Dr.Nalli R. Gopinath, Dr.Muthazhagan, Dr. Prabaharan*** *Assistant Professors of this department for their suggestions and help during this study.*

I thank all anesthesiologists and staff members of the theatre for their endurance during this study.

I am grateful to all post graduate colleagues for helping me in this study.

I thank my parents and friends who lended moral support for me.

Last but not least, my sincere thanks to all our patients, without whom this study would not have been possible.

CONTENTS

INTRODUCTION

Cervical spine injuries usually occurs secondary to high energy trauma including motor vehicle accident (45%) and fall from height (20%).

Less commonly, cervical spine injuries occur during sports activities (15%).

Neurological injury occurs in 40% of patients with cervical spine fractures.

Spinal cord damage more frequently occurs with lower cervical spine injuries.

Early recognition, immobilization, preservation or restoration of spinal cord function, and stabilization are the key to successful management of patients with cervical spine injuries

Cervical instability due to trauma is usually from the level of c3 to c7. Neurological deficits are common in these levels

Unstable cervical spine injuries with or with out neurological deficit require open reduction

Stabilization is done by using various implants and bone grafting. Implants provide immediate stability, where as bone grafts provide long term stability by achieving intervertebral fusion

Posterior plate utilizing lateral mass plate fixation with supplemental bone grafting is being employed for treating an unstable cervical spine caused by trauma and other causes since Roy Camille first introduced screws into the lateral masses of cervical spine to stabilize the unstable spine in 1964 (Ebraheim et al 2005)

We have done the Lateral mass fixation for unstable lower cervical spine injuries with facetal joint dislocation

AIM OF THE STUDY

To evaluate

- applicability
- safety
- radiologically observed efficacy
- neurological out come
- complications

HISTORICAL REVIEW

1550 BC- Egyptians in the Edwin Smith Payrus considered acute neck injury as “an ailment not to be treated”

460-377 BC- Hippocrates introduced the methods of traction in prone position for treating spinal injuries

Hildanus first introduced the technique for reducing fracture dislocation of cervical spine

Paul of Agenda suggested surgical excision of the fractured spinous processes for treating traumatic spinal disorders

Malgaigne said all spine fractures resulted in paralysis

1856-1904- Chipault –a French surgeon published the first text book on spinal surgery presenting the most complete survey of past and current spinal surgery

The specialist year book “Travaux de neurological churgicale”, first neurosurgical journal in the world

In 1904, he published, “Manual de orthopeadic vertebrale”, which primarily dealt with the orthopedic treatment of spinal disorders.

1866-1945- Sudeck explained how to radiograph the spine methodically

1877- Bouterou-first described how to reduce fractures with weight attached by adhesive tape to the patients face.

1925- John Davis- first described the lateral view of cervical spine

1928- Stuckey approached the cervical spine anteriorly for a chordoma

1929- Taylor introduced head –halter traction

1933- Crutchfield introduced head holding tongs

1958-Cloward introduced the anterior approach for degenerated disc.

Cloward introduced the anterior arthrodesis using a cylindrical dowel of iliac crest graft

1960- Bailey & Badgiey described the method of anterior cervical fusion of the traumatic cervical spine using iliac crest graft

1962- Robinson – anterior arthrodesis using horse – shoe shaped iliac crest graft

1964- Roy Camille in France- first to insert screws in lateral mass to stabilize unstable spine. Magrel in Switzerland followed him.

ANATOMY

DEVELOPMENTAL ANATOMY OF CERVICAL SPINE:

Antenatal Development:

During third week of intrauterine life, development of mesoderm on both side of neural tube and the notochord becomes aggregated to form SOMITES. Somites differentiate into ventromedial part (the sclerotome) and dorsolateral part (the dermatomyotome). During fourth week, selerotome forms the vertebrae, ribs and spinal ligaments, while the dermatomyotome forms the musculature and dermis of scalp, neck & trunk.

The cranial half of first cervical selerotome fuses with the caudal portion of fourth occipital somite to form basilar portion of occipital bone. Caudal half of first cervical selerotome fuses with cranial half of second cervical selerotome to form first cervical vertebra. The same type of fusion is repeated down the length of cervical spine.

Postnatal development:

Ossification centers in lateral masses that expand into posterior arches join by about 3 years of age. A secondary ossification centre develops in the anterior arch of the cervical vertebra by one year of age. It fuses with the lateral masses by 6 to 9 years.

Clinical Anatomy:

Vertebral column is made of 5 parts viz., cervical, thoracic, lumbar, sacral & coccygeal parts. Cervical spine consists of 7 vertebral; first two of which Atlas & Axis are atypical. C3 to C7 are typical.

Typical Cervical Vertebrae:

They are structured to provide limited flexion, extension, tilt and rotation as well as the provide stability to support the head. Vertebral bodies have a superior surface, which is convex anteroposteriorly and concave laterally. This configuration allows flexion, extension, lateral tilt by gliding movements of facets. Inferior surface of vertebral body is convex. Lateral aspect of body has superior projection called uncinate process.

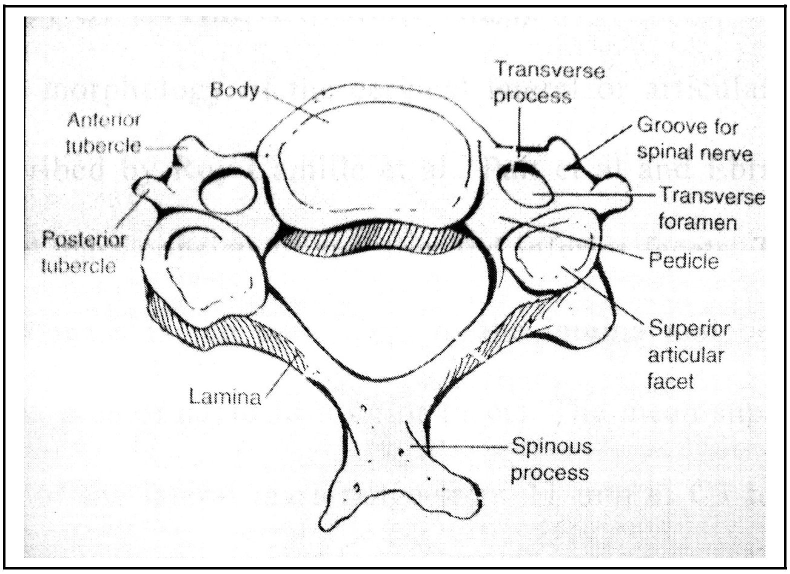
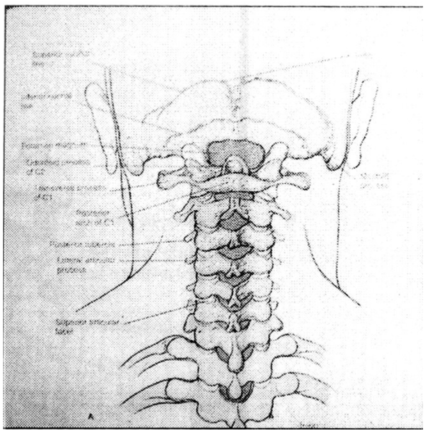


Fig.1:

The lamina and spinous process of C2 are the largest, whereas C3, C4 & C5 have thin laminae to help assume the normal lordotic posture. The spinous processes of third, fourth and fifth cervical vertebrae are bifid. The laminae of sixth and seventh cervical vertebrae become progressively thickened and larger to approach the size of thoracic vertebrae. The facetal joints are placed in a coronal plane angled 45^0 to the horizontal. Due to this 45^0 inclination, lateral tilt is accompanied by rotation and vice versa. The gliding motion of the facets allows flexion, extension and lateral tilt.

ANATOMY OF LATERAL MASS:

The morphology of the cervical lateral or articular mass has been described by Roy Camille et al. (1989), and Ebrahim et al (1998). The lateral mass consists of superior and inferior facets. The area of the lateral mass is the part lateral to the lamina and between the inferior margins of adjacent inferior facets. The mean superoinferior diameters of the lateral mass range from 11 mm at C3 to 15mm at C7, and mean mediolateral diameters range from 12 to 13mm at C3 through C7. The mean antero-posterior diameter of the lateral mass is smaller at C6C7 levels than at levels above.



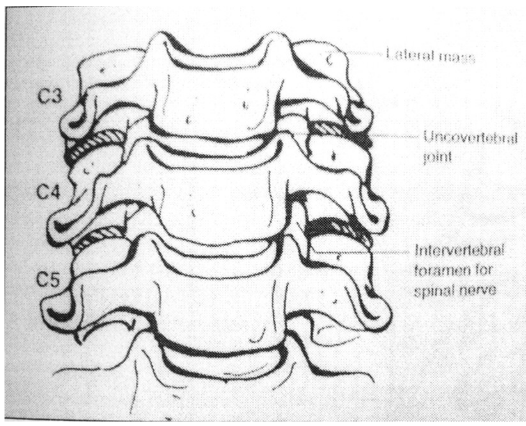


Fig. 2 & 3

In the transverse plane, the transverse foramen lies anteromedial to the posterior centre of lateral mass at the levels of C3 to C5. At C6, it courses laterally, and lies infront of the posterior center of lateral mass.

THE SPINAL NERVE:

Spinal nerve exist the spinal canal passes through the interpedicular foramen. Laterally in the intertransverse foramen, it divides into a large ventral ramus and a smaller dorsal ramus. The ventral ramus of the cervical spinal nerve courses on the transverse process in the anterolateal direction to form the cervical and brachial plexus.

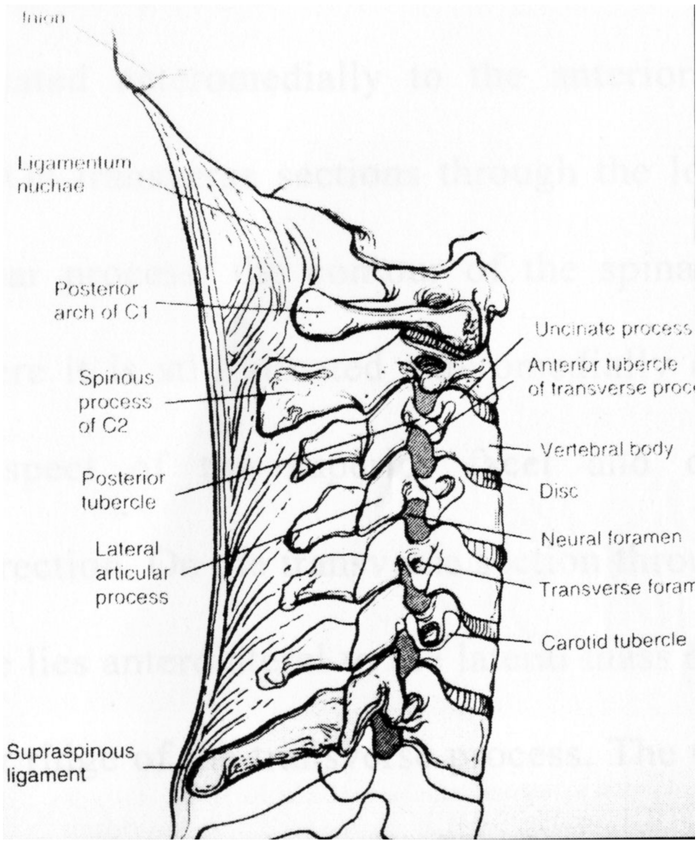


Fig.4:

On the oblique sagittal images, the cervical nerve root is located in the lower part of the interpedicular foramen and occupies the major inferior part of the intertransverse foramen. On the posterior aspect of the lateral mass, the mean distance is about 5.6 mm from the posterior centre of the lateral mass to the projection of the spinal nerves superiorly and inferiorly for all levels. Pait divided the lateral mass into 4 quadrants, and found that the superolateral quadrant is away from the spinal nerve. On the transverse sections through the upper portion of the superior articular process, the spinal nerve either does not appear, or when it does, it is situated anteromedially to the anterior aspect of the superior facet. On transverse sections through the lower portion of superior articular process, the contour of the spinal nerve is best delineated, where it is still situated anteromedially or anteriorly to the anterior aspect of the superior facet and courses in the anterolateral direction. On the transverse section through the pedicle, the spinal nerve lies anterolateral to the lateral mass and is separated by the posterior ridge of the transverse process. The C7 spinal nerve is relatively larger and closer to the anterior aspect of the lateral mass due to its more posterior course in the transverse plane.

THE VERTEBRAL ARTERY:

Vertebral artery originates from the subclavian artery, enters the transverse foramen of the sixth cervical vertebra, and courses upward through the foramen above. On the transverse plane, the vertebral artery lies in front of the lateral mass, but is separated by the spinal nerve.

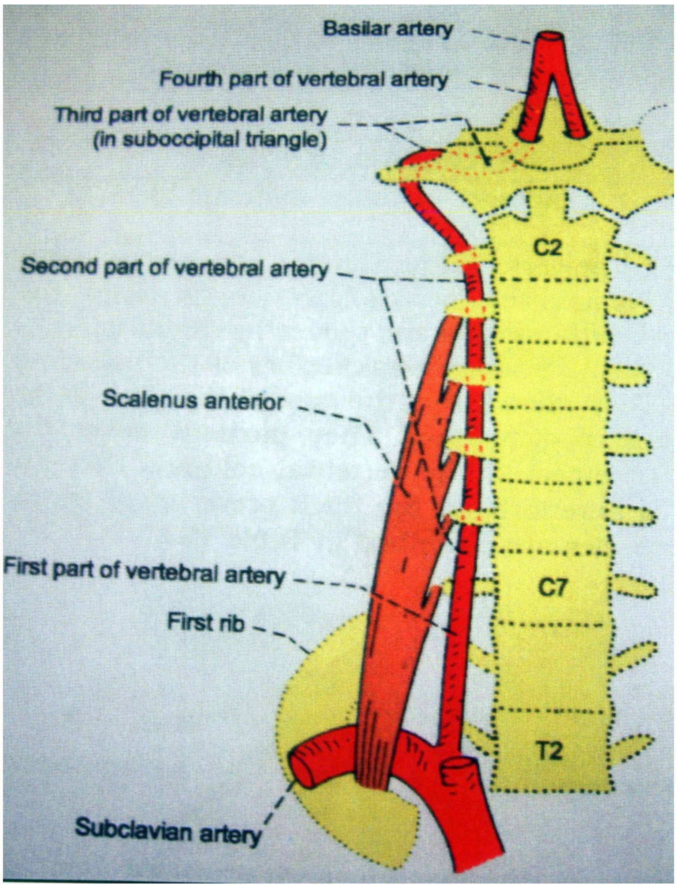

Basilar artery
Fourth part of vertebral artery
Third part of vertebral artery
(in suboccipital triangle)
C2
Second part of vertebral artery
Scalenus anterior
First part of vertebral artery
C7
First rib
T2
Subclavian artery

Fig.5

BIOMECHANICS OF LOWER CERVICAL SPINE

KINEMATICS OF CERVICAL SPINE:

In spinal kinematics, the motion is usually described in relation to adjacent vertebra. The secondary coordinate system may be established in the body of adjacent vertebra.

The most detailed and convincing work on kinematics of cervical spine was done by White & Punjabi. The spine is a mechanical structure. The vertebrae articulate with each other in a controlled manner through a complex of levers (vertebrae), pivots (facets & discs), passive restraints (ligaments) and activators (muscles). The major portion of mechanical stability of spine is due to highly developed, dynamic neuromuscular control system.

STRUCTURES ALLOWING MOTION:

The sub axial (below C2) spine contributes approximately 50% of flexion - extension and rotation of cervical spine. The orientation of posterior facet joints (45^0 angles in the coronal plane) allows for more mobility than is possible in the other spine regions. Motion at the facet joints is also complemented by concomitant motion between vertebral bodies through the intervertebral discs. The uncovertebral joint, not a true diarthroidal joint also contributes to cervical mobility.

STRUCTURES RESISTING COMPRESSION & DISTRACTION:

Compressive forces applied in an axial mode are supported or resisted by the vertebral body, the intervertebral disc, the uncovertabral joints of anterior and middle columns, and the facets and lateral messes of posterior columns. The result is a tripod of support made up primarily of the vertebral body and two lateral masses with associated facet joints.

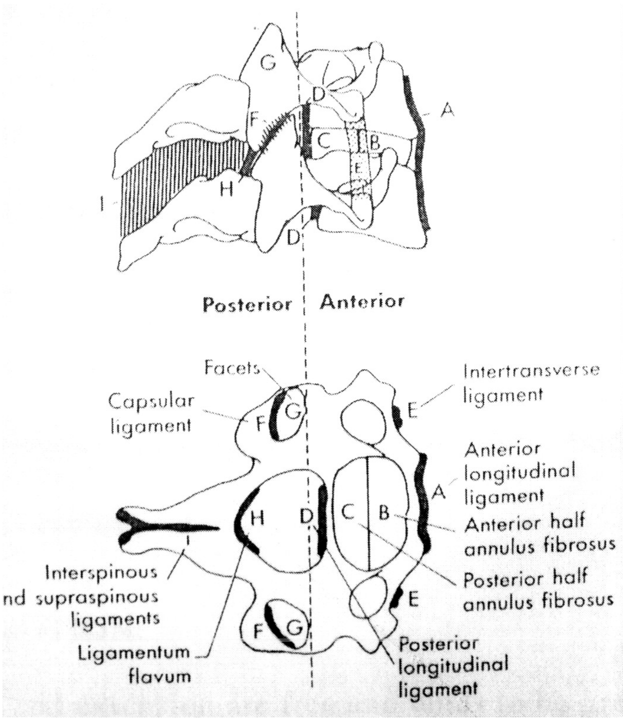


Fig. 6: Ligamentous attachments

The ligaments of the cervical spine function primarily to provide resistance to distractive forces. Distraction of the anterior column is limited by anterior ligamentous complex and posterior column by posterior ligamentous complex.

STRUCTURES LIMITING MOTION:

Because movement of neck places both compressive and distractive forces on the cervical spine, both bony & ligamentous structures assist in limiting motion. During flexion, compression occurs in anterior column, distraction occurs in posterior column. Flexion is therefore limited by vertebral body, intervertebral disc and posterior ligamentous complex. Likewise extension places compressive forces on posterior column and distractive forces on anterior column. Resistance to extension is therefore provided by lateral map or facet complex and anterior ligamentous complex. Lateral flexion to one side is limited by contralateral facet capsule and annulus fibrosus and by ipsilateral vertebral body and lateral mass or facet complex.

RANGE OF MOTION:

Flexion and extension are free and tends to be greeter at C5 C6 & C6C7 interspace where they total 17 degree and 16 degree respectively. Lateral bending and rotation are most free at C3C4 & C4C5 levels where they total 11 degree. Neck movements diminish with age. Forward flexion should normally allow chin to touch the chest. Extension can sometimes allow skull to touch the back. In lateral flexion, ear should touch the shoulder.

IMPLANTS - OPTIONS

Posterior Instrumentation:

1. Lateral mass fixation with one-third tubular plates.

2. Lateral mass fixation with recon plates.

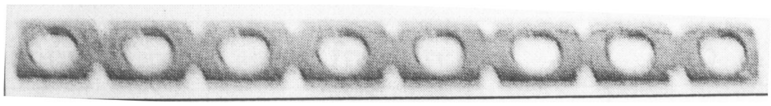


Fig. 7

CERVICAL SPINE INSTABILITY

Stable injury involves only one column, whereas unstable injury involves both columns.

White & Punjabi defined instability as the loss of ability spine under physiologic loads the maintain relationships between vertebra in such a way that there is neither damage nor subsequent limitation to spinal cord or nerve roots. Clinical instability can be defined as any interruption in normal smooth translation of vertebral biomechanics as evidenced by jerky or excessive spinal movements.

WHO SCORING SYSTEM:

S. No	*Score card for clinical instability*	*Points*
1.	Positive stretch test	20
2.	Spondylosis or degenerative disc disease developing within 3 years of injury	20
3.	Plain film evidence of instability	15
4.	Video Fluoroscopic evidence of instability	15
5.	Any documented clinical spine fractured	15
6.	Spinal cord or nerve root irritation subsequent to injury	15
7.	Initial neurological symptoms lasting longer than one week	5
8.	Intractable pain resulting from injury	05
9.	Spondylolysis or degenerative disc disease present at time of injury	05

> 30 means definite clinical instability.

>20 means instability probable

10-20 means clinical instability possible.

<5 means clinical instability unlikely.

Check for diagnosis of clinical instability:

S.No	*Element*	*Point value*
1.	Anterior element destroyed or unable to function	2
2.	Posterior element destroyed or unable to function	2
3.	Relative sagittal plane translation >3.5mm	2
4.	Relative sagittal plane rotation >11 degree	2
5.	Positive stretch test	2
6.	Cord injury	2
7.	Root Injury	1
8.	Abnormal disc narrowing	1
9.	Congenital spinal stenosis	1
10.	Dangerous loading anticipated	1
		>5 = Clinical instability

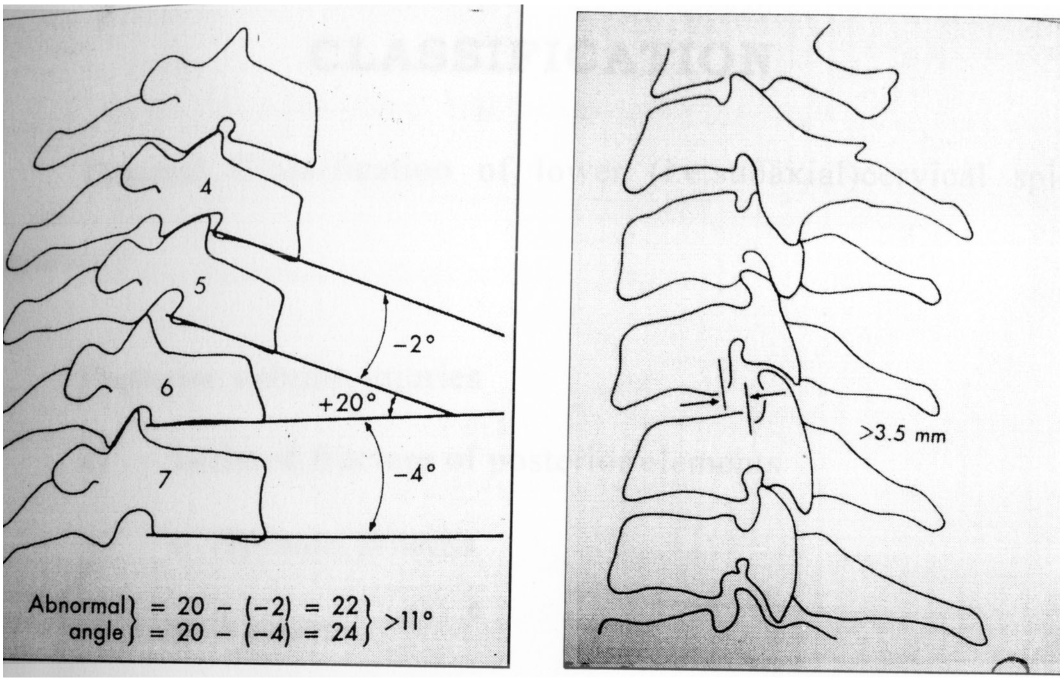


Fig.7 Sagittal angulation & Sagittal Translation

CLASSIFICATION

General Classification of lower cervical spine injuries –

1. Posterior column injuries
   a) Isolated fixture of posterior elements
      i. Spinous process
      ii. Lamina
      iii. Transverse process
   b) Posterior ligamentous injury
      i. Mild
      ii. Severe
   c) Hyperextension injury with spinal cord injury

2. Facet Injuries
   a) Isolated facet or pedicle fractures
   b) Unilateral facet dislocations
      i. Unilateral facet dislocation
      ii. Unilateral facet fracture with subluxation
      iii. Fracture separation of lateral mass
   c) Bilateral facet dislocation
      i. Bilateral facet dislocation

ii. Bilateral facet fracture with dislocation

iii. Bilateral facet fracture dislocation with traumatic disc herniation, distraction injury.

3. Anterior column injury

a. Vertebral body compression fracture

b. Vertebral body compression fracture with posterior ligamentous injury.

c. Discoligamentous extension injury

d. Extension teardrop fracture

e. Traumatic retrolisthesis

f. Stable burst fracture

g. Unstable burst fracture

h. Flexion teardrop fracture

ALLEN ETAL MECHANISTIC CLASSIFICATION:

a. Compressive Flexion (CF)

Stage I Blunting of anterosuperior vertebral body margin.

Stage II Beak appearance of the anterosuperior vertebral body margin

Stage III	Oblique primary fracture line that extends from the anterior vertebral body to the inferior and plate, so called tear drop fracture.
Stage IV	Stage III & Posterior translation of upper vertebra measuring <3mm.
Stage V	Posterior translation of upper vertebra measuring >3mm, facet gapping, indicating anterior and posterior ligamentous injury.

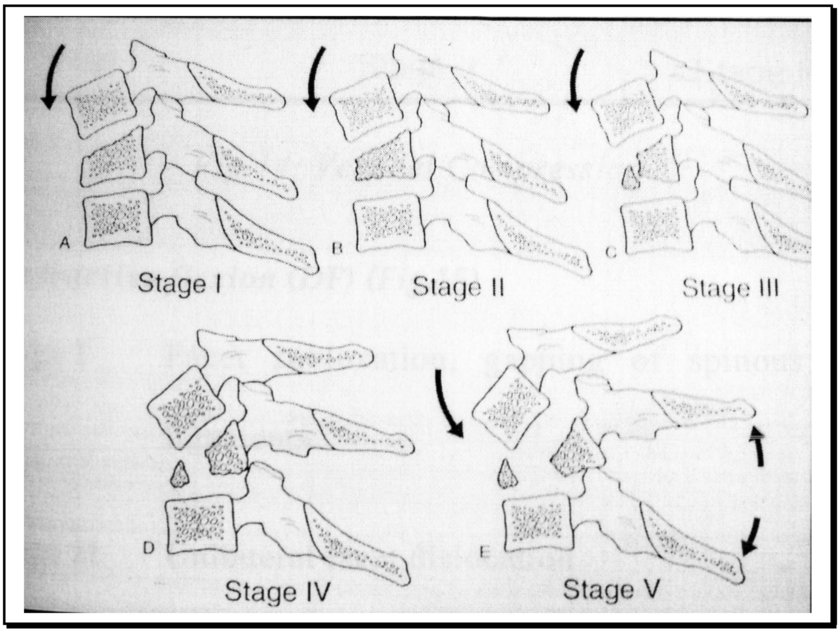


Fig. 8. Compressive Flexion

b. Vertical compression (VC)

Stage I Central superior or inferior end plate fracture

Stage II Superior and inferior end plate fractures

Stage III Vertebral body comminution, with or without retropulsion of fragments, with or without Kypholic or translational deformity.

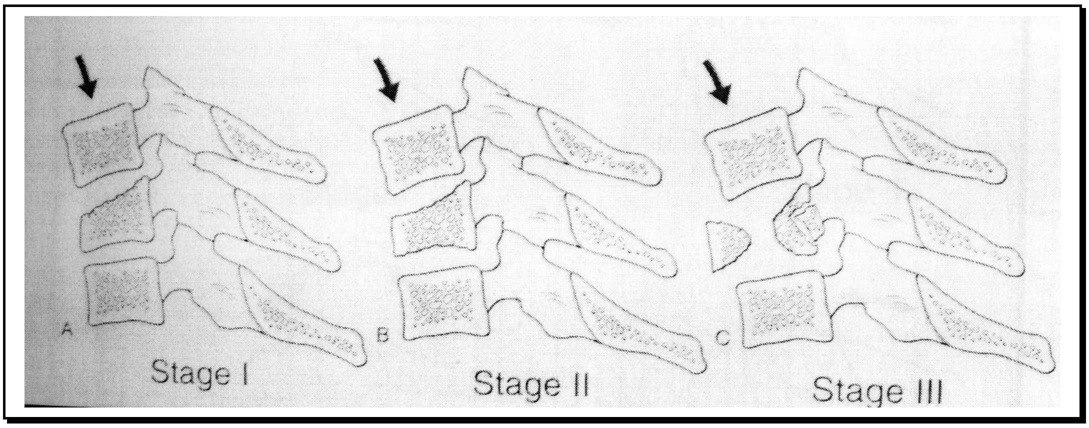


Fig.9. Vertical compression

c. *Distractive flexion (DF)*

Stage I Facet subluxation, gapping of spinous process ligaments.

Stage II Unilateral facet dislocation

Stage III Bilateral facet dislocation, 50% translation of upper vertebral body on lower one.

Stage IV Close to 100% translation of upper vertebral body on lower one, so called floating vertebra.

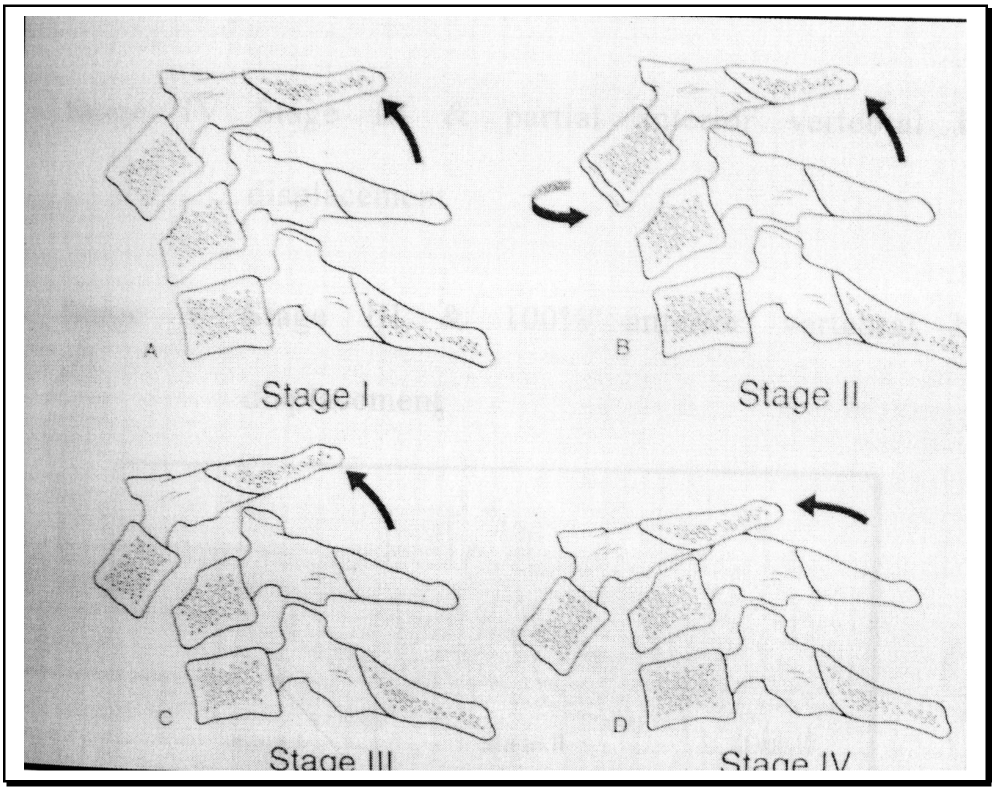


Fig. 10: Distractive Flexion

d. Compressive Extension (CE)

Stage I	Posterior arch fracture that may be facet, pedicle or lamina fracture, with or without rotation
Stage II	Bilateral lamina fractures, can be multiple levels
Stage III	Bilateral lamina, pedicle, and facet fractures without vertebral body displacement, so called floating lateral mass fractures

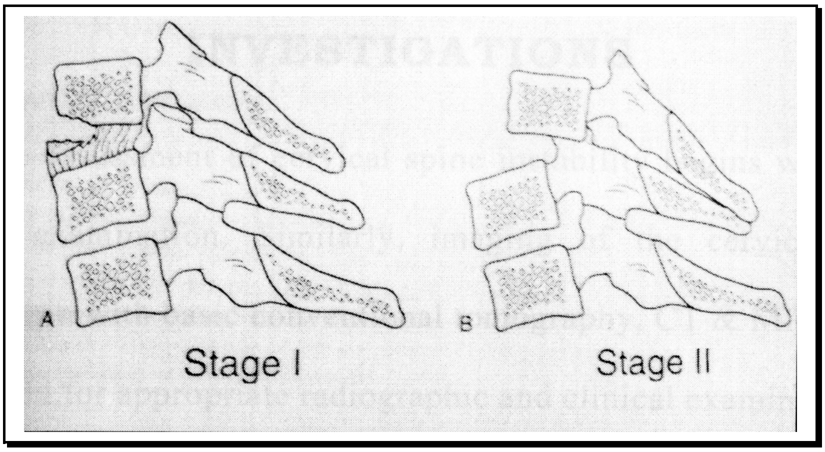


Fig.11: Distractive Extension

e. Distractive extension (DE)

Stage I Abnormal widening of disc space

Stage II Stage I & Posterior translation

f. Lateral flexion (LF)

Stage I Unilateral uncovertebral fracture or asymmetric vertebral body compression

Stage II Vertebral body or posterior arch fractures with lateral translation or unilateral facet gapping, coronal angular deformity is noted on an AP X-ray.

INVESTIGATIONS

The assessment of cervical spine instability begins with basic physical examination. Similarly, imaging of the cervical spine should begin with basic conventional tomography. CT & MRI should be reserved for appropriate radiographic and clinical examination.

RADIOGRAPHY:

AP View - Recognised structures include vertebral bodies, superior and inferior and plates, disc spaces, uncinate processes, which, together with the inferolateral aspect of the supradjacent vertebral body can be seen.

Lateral view - recognized structures include vertebral body, disc spaces, U-shaped transverse process superimposed on the vertebral body, articular masses, adjacent facets, interfacetal joint, lamina and spinous processes.

Pull down lateral view - demonstrates:

1) C7T1, Apophyseal joints
2) Superior end plate of T1
3) Anterosuperior aspect of body of T1

4) Cervicothoracic preventeral soft tissue shadow

Swimmer's view - is taken in a position of arms similar to the Australian free style swimming stroke position. It gives osseous superimposition & typically seriously observes visualization of the middle and posterior columns of the C7 vertebra.

Trauma oblique view - taken in which the cassette is placed as far as possible posterior to the shoulder, neck and head without moving the supine patient. X-ray tube is placed to the opposite side centered on the thyroid cartilage and angled at 35^0. This is repeated on the contralateral side. It gives slightly distorted view by magnification. It is useful in patients with short neck, requires no patient movements or co-operation and demonstrates the posterolatral aspects of C7 vertebra.

Right & left oblique view - shows posterolateral aspects of vertebral body, pedicle, and intervertebral foramen.

CT scan - Shows the body of the dislocated vertebra anterior the uncinate process and body of the subjacent vertebra and the dislocated anterior masses anterior to the subjacent masses in this configuration, the uncovered nabbed superior facets of the subjacent vertebra will be clearly evident.

MRI - determines the extent and type of spinal cold injury, presence of other intraspinal pathology, assess ligamentous and disc injury, also assess the status of posterior longitudinal ligament in retropulsion of the disc at the level of injury.

Myelogram - will show the extent of disc compression over the spinal cord, spinal nerves and the fragments compression the spinal cord.

TREATMENT PROTOCOL AND SURGICAL PROCEDURE

The goal of treatment of spinal cord injury:

- decompress neurological elements
- preserve neurological elements
- avoid secondary injury
- restore anatomical spinal alignment
- restore spinal stability

Initial Management:

- hard cervical collar, rigid spine board at the scene of injury or prior to first examination
- fluid and electrolyte management
- asses neurological status

Methyl prednisolone if injury is <8hrs old. Dose 30mg/kg in first 15 minutes and 5.4 mg/kg/hr for next 23 hrs

Skull tong traction.

Gardner well tongs are inserted in line with the external auditory meatus, just 1-2 cm above the auricle. Weight of 5-10 pounds per interspace (for example-C4-20pounds, C5-25 pounds) is applied. A repeat neurological examination is performed and lateral radiograph is taken.

Indications :(Lali 2005)

- traumatic cervical spine instability
- neoplasm
- spondylomyelopathy
- failed anterior fusion

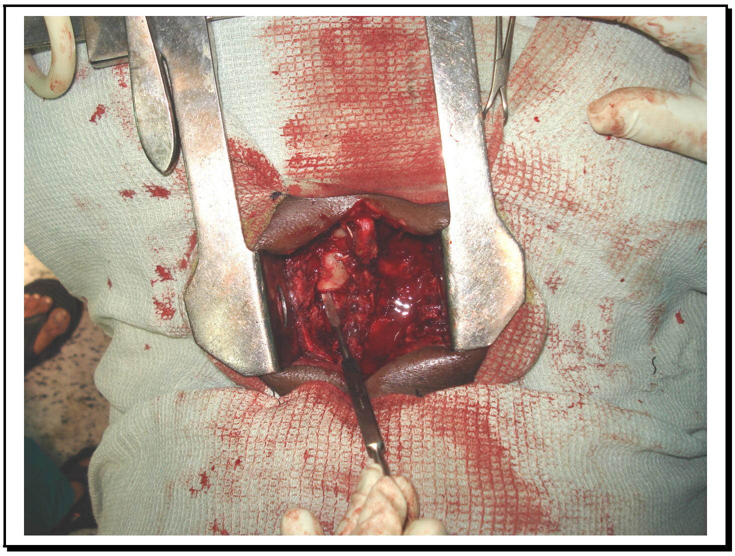
Surgical Technique:

Position- prone on Stryker s frame with skull tong traction to assist in reduction.

Incision- posterior midline exposure is used. Lateral masses of injured spine alone are exposed.

Reduction of subluxation or dislocation

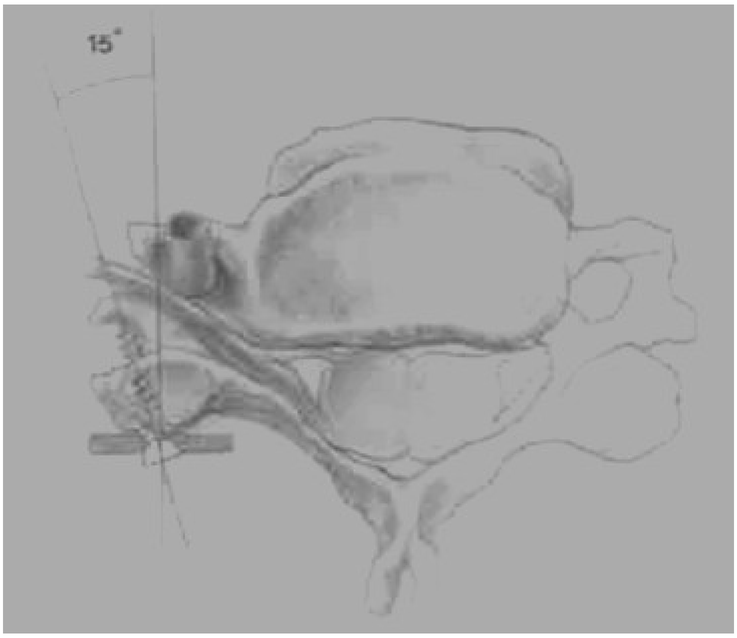
The spinous process can be manipulated as levers using Kocher clamps or Towel clips. A small elevator, such as Freer, can be inserted in to the dislocated facet joint and levered in an attempt to unlock the joint. If necessary, the cranial aspect of the superior facet can be removed with a burr to unlock the facet.



Roy – Camille Technique:

The spine alignment and appropriate level were identified anatomically. The attention was then turned to lateral mass screw placement. The midpoint of the lateral mass was identified and pierced with an awl. This point was drilled free hand with a *2-mm* drill bit perpendicular to the posterior vertebral plane and 10-15° laterals to the sagittal plane (Fig. 1).

Figure 13:
Illustration of Roy-Camille screw placement
in relation to the nerve root and the vertebral artery



The drill hole was further tapped with a *3.5mm* tap, and its depth was measured with a calibrated depth gauge. Two contoured Roy-Camille cervical plates of appropriate length were placed and cortical screws of 3.5mm diameter and from 14 to 16mm length were inserted bi-cortical. During the procedure, fluoroscopic lateral and oblique projections were routinely used to assess the position of screws. Finally, the posterior elements adjacent to the plates were decorticated and the autogenous bone grafts from the posterior iliac crest were added.

RADIOLOGICAL CONSIDERATIONS

Intraoperative fluoroscopy is a commonly used radiological modality in assisting lateral mass screw placement. The lateral projection of fluoroscopy may be the most convenient view to direct each screw insertion or evaluate the screw position after screw placement. This projection displays the facet joints and the posterior borders of the vertebral bodies. Facet joint violation, a possible complication in wrongly directed screws or in difficult cases with degenerative changes may occur. The lateral view of radiographs may help in diagnosis of this iatrogenic injury. However, the anterior portion of the lateral mass is not visible in this view because it is superimposed on the posterior border of the vertebral body. Screw trajectory in the sagittal plane and its relation to the facet joint can be assessed clearly in the lateral fluoroscopy. Recently, the value of the lateral fluoroscopy in determining the Roy-Camille screw length has been evaluated. Ebraheim and Xu et al(1998) [19] found that most of the screw tips placed in the ventral cortex of the lateral mass were located in the posterior one fourth of the vertebral body just anterior to the posterior border of the vertebral body. The exit point for the Roy-Camille screw is located just lateral to the origin of the transverse process, which projects anterior to the posterior border of the vertebral body on the sagittal plane. Ebraheim and Xu et al (1996) [21, 24] suggested that the screw length might be proper and safer if the tip of a Roy Camille screw is located just anterior to the posterior border of the vertebral body as seen on the lateral radiograph. The oblique projection of fluoroscopy is also valuable in evaluating the relationship of lateral mass screw to the intervertebral foramen after screw placement. The oblique view of the cervical spine best demonstrates the shape and size of the intervertebral foramen, the surrounding pedicles, the posterolateral corner of the vertebral body, and the anterolateral aspect of the lateral mass. The oblique radiograph could detect an excessively long screw that invades the intervertebral foramen. The line connecting the posterior borders of the intervertebral foramina may be considered a useful landmark for surgeons to determine whether or not a screw is too 1ong Well man and Follet et al [22]. If the tip of a screw crosses this line, the screw has most likely over-penetrated. Because the exiting cervical spinal nerve occupies the lower portion of the intervertebral foramen and courses laterally and inferiorly, the spinal nerve may be at high risk of injury if the tip of a screw is seen in the lower portion of the intervertebral foramen or is superimposed on the upper portion of the pedicle on the oblique radiograph - Ebraheim and Xu et al (1996) [20, 23].

In contrast, the spinal nerve may be not compromised if the tip of a screw is seen in the top of the intervertebral foramen. In this case, replacement of the screw in an asymptomatic patient is unnecessary.

Computed tomographic scans (CT) has been recommended as a useful radiologic means for preoperative evaluation of the dimensions of the lateral masses of the cervical spine and postoperative evaluation of lateral mass screw position. The screw orientation in the transverse plane and the screw length can be clearly appreciated in axial CT scans.

However, it is difficult to determine if an over-penetrated screw compromises the spinal nerve or not - Ebraheim and Xu et al (1997) [24]. A reconstructed image in the sagittal or oblique sagittal plane may delineate the relationship of the over-penetrated screw to the spinal nerve.

POST OPERATIVE PROTOCOL

- drain removed on 2^{nd} post op day
- patient made to sit with hard cervical collar
- suture removal on 12^{th} post op day
- Back, bowel and bladder care given on alpha bed.
- external cervical orthrosis used up to 6^{th} post op week
- physiotherapy
- neck mobilization with out collar after 6 weeks
- X ray taken periodically-immediate post op, 1st month and every 6^{th} month.
- rehabilitation and occupational therapy given

COMPLICATIONS IN LITERATURE

- nerve root injury
- vertebral artery injury(Cho KH,ShinYS –PubmedID 16099249)
- loss of reduction(Lali 2005)
- screw pull out (Lali 2005)
- infection
- graft donor site morbidity

MATERIALS AND METHODS

This is a prospective study of 20 cases of unstable subaxial cervical spine injuries at Government General Hospital, Chennai from May 2006 to Sep 2008.

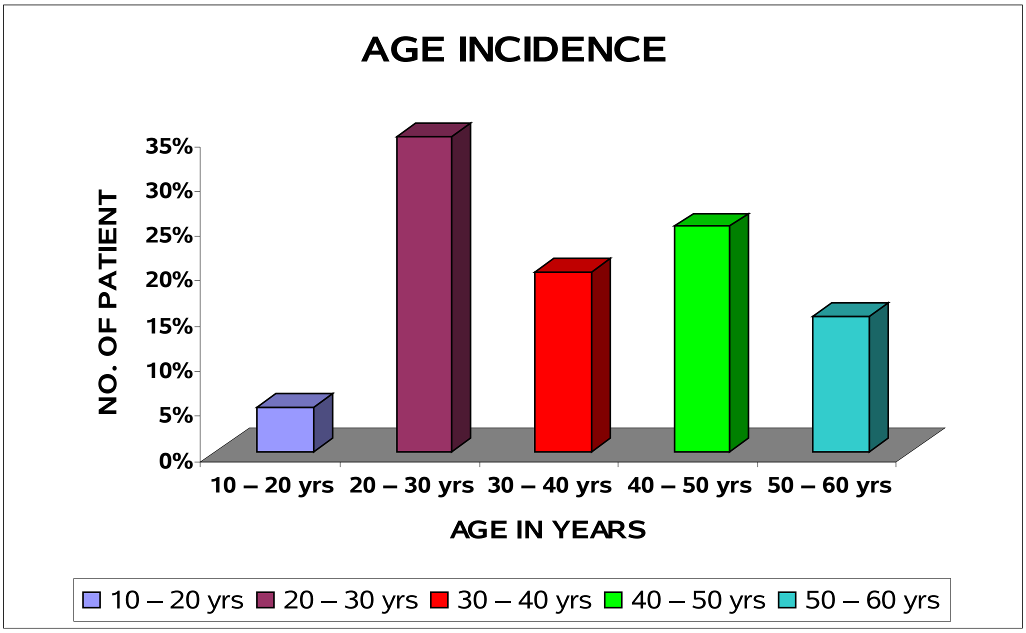
INCLUSION CRITERIA:

All unstable subaxial cervical spine injuries with facetal joint dislocation were included in this study.

AGE INCIDENCE:

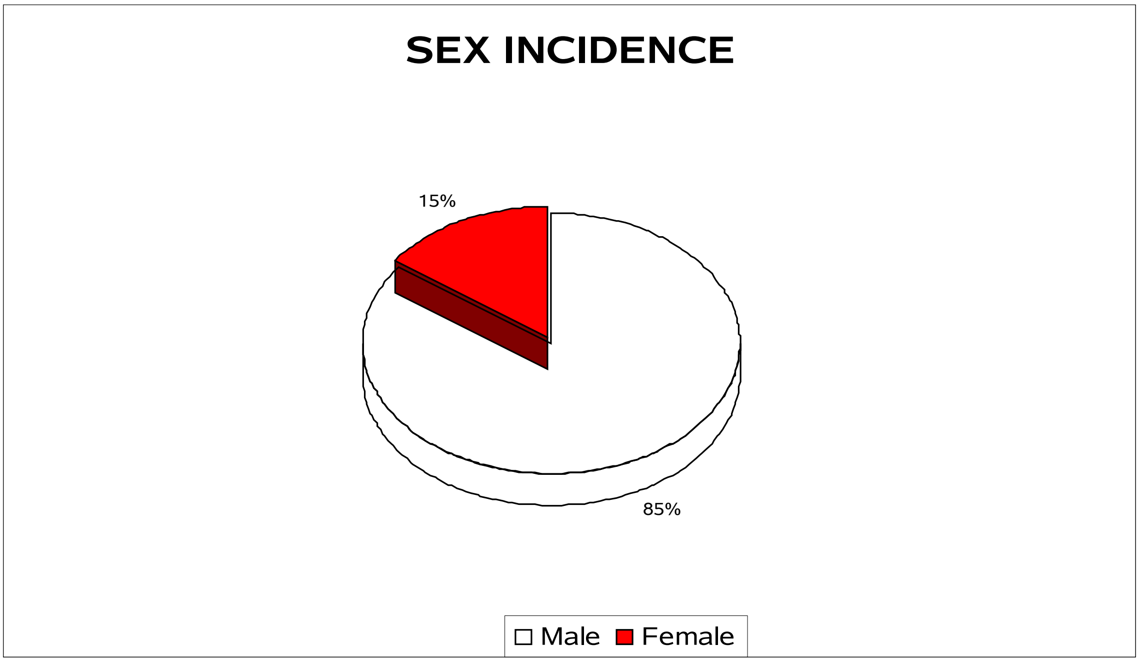
Age of the patients ranged from 19yrs to 60 yrs

Age	*No. of patients*	*Percentage*
10 – 20 yrs	1	5%
20 – 30 yrs	7	35%
30 – 40 yrs	4	20%
40 – 50 yrs	5	25%
50 – 60 yrs	3	15%



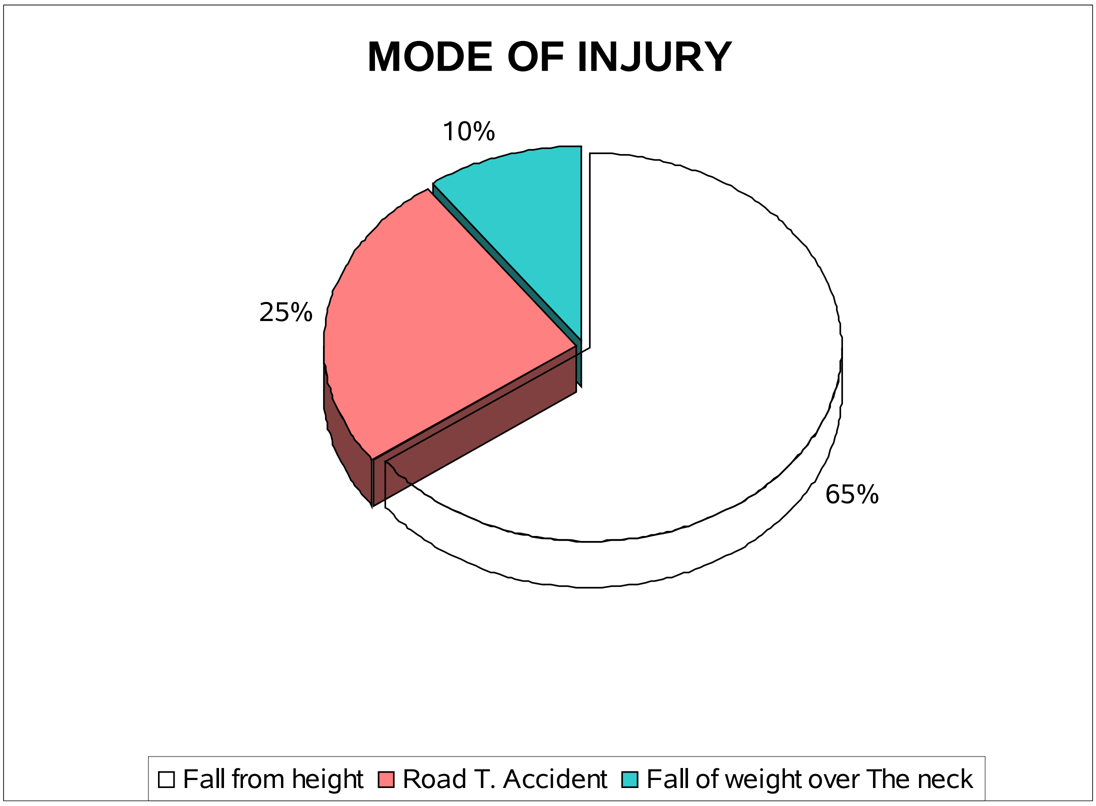
Sex Incidence:

Sex	*No. of patients*	*Percentage*
Male	17	85%
Female	3	15%



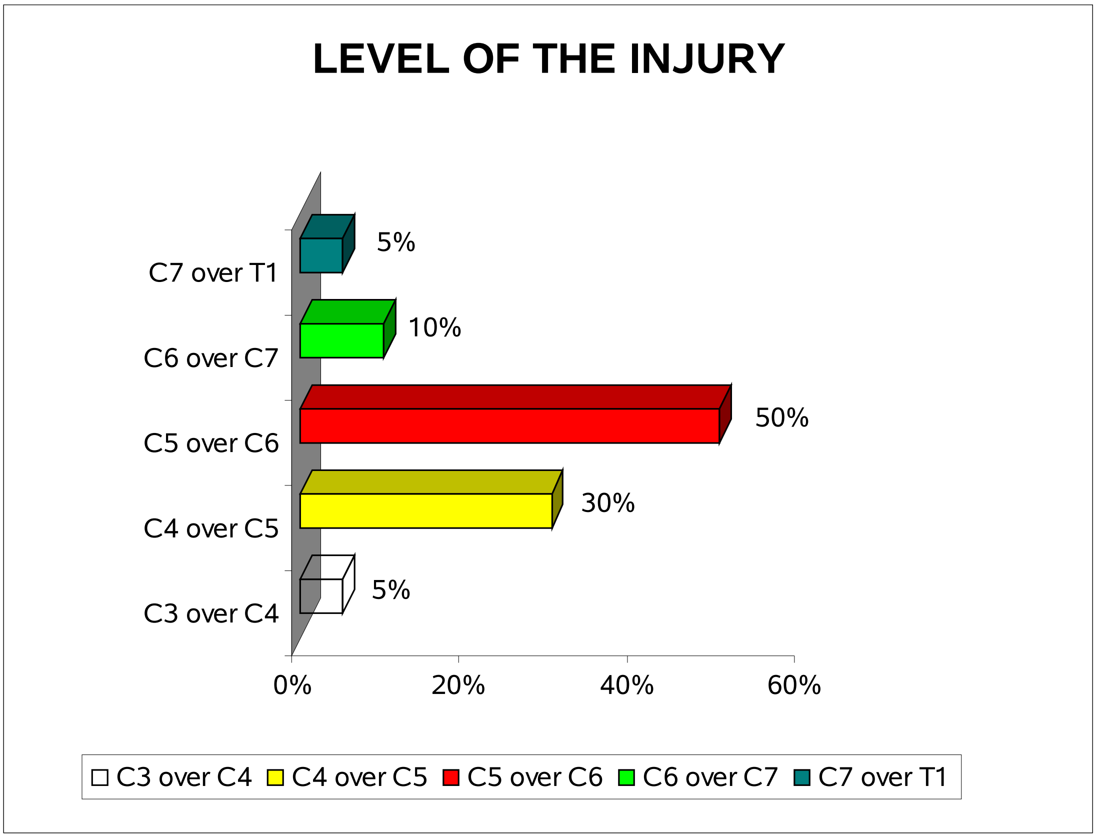
Mode of injury:

Mode of Injury	***No. of patients***	***Percentage***
Fall from height	13	65%
Road T. Accident	5	25%
Fall of weight over The neck	2	10%



LEVEL OF THE INJURY:

Level	*No. of patients*	*Percentage*
C3 over C4	1	5%
C4 over C5	6	30%
C5 over C6	10	50%
C6 over C7	2	10%
C7 over T1	1	5%

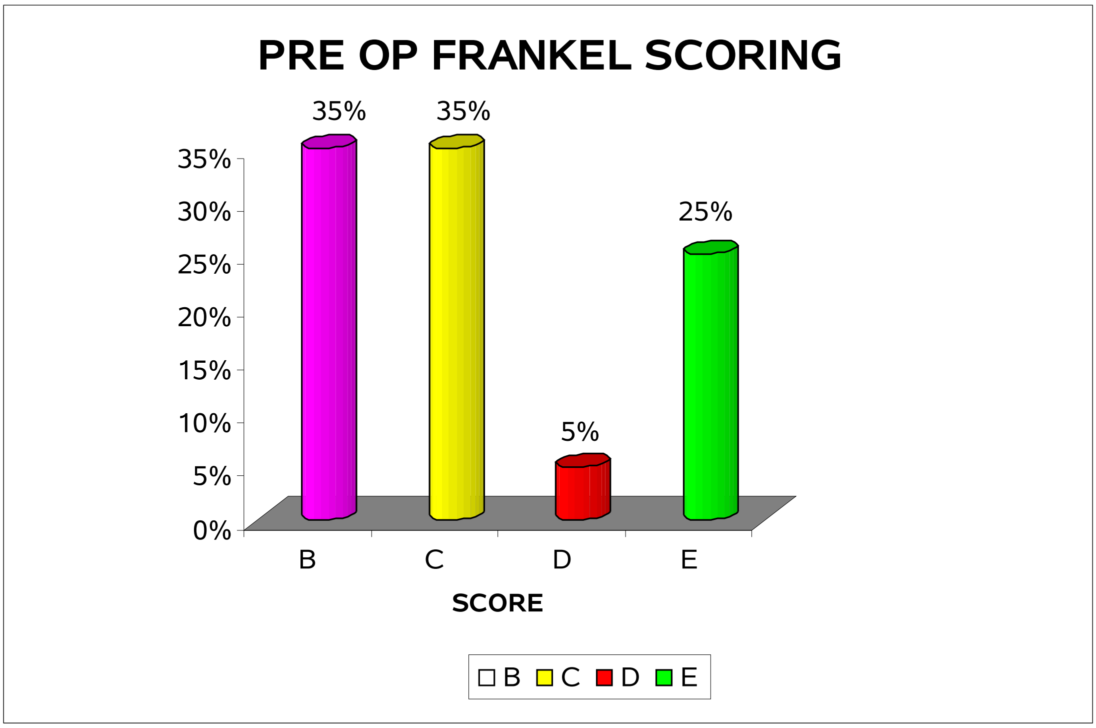


NEUROLOGICAL DEFICIT:

Neurological Status	*No. of patients*	*Percentage*
Partial deficit	15	75%
Without deficit	5	25%

PRE OP FRANKEL SCORING :

Score	*No. of patients*	*Percentage*
B	7	35%
C	7	35%
D	1	5%
E	5	25%



TIME OF PRESENTATION:

Time interval since injury	*No. of cases*
With in 24 hrs	11
1 day to 1 week	3
1 week to 1 month	5
More than 1 month	1

INVESTIGATIONS

Clinical signs were recorded. Basic blood investigation was done. Appropriate radiographs, CTscan were taken to rule out canal compromise, facetal instability.

PRE OPERATIVE TREATMENT:

Life supporting measures were taken. Skull tong traction applied immediately. Measures taken to avoid occurrence of back sores, Bladder related complications.

Anesthesia – Endotracheal general anesthesia administered.

TIME INTERVAL:

Time interval between admission and surgery was 11 days to 35 days.

BONE GRAFTS:

Autogenous cancellous graft is harvested from posterior iliac crest and nibbled spinous processes were used in all cases.

IMPLANTS USED:

Recon plate (3.5 mm) and cortical screws (14mm into 3.5 mm) were used.

LEVEL OF FUSION:

Level	*No. of patients*	*Percentage*
C3 - C4	1	5%
C4 - C5	6	30%
C5 - C6	10	50%
C6 - C7	2	10%
C7 - T1	1	5%

POST OP PROTOCOL:

1. Drain removed on 2nd post op day

2. Patient made to sit with hard cervical collar

3. Suture removal on 12th post op day

4. Back, bowel and bladder care given on alpha bed.

5. External cervical orthrosis used up to 6th post op week

6. Physiotherapy

7. Neck mobilization with out collar after 6 weeks

8. X-ray taken periodically-immediate post op, 1stmonth and every 6th month.

9. Rehabilitation and occupational therapy given.

FOLLOW UP:

Periodical follow up by assessing post op neurological outcome using Frankel grading system. Radiological assessment is done for fusion and maintenance of reduction.

Maximum of 28 months

Minimum of 4 months

OBSERVATIONS

In this study majority of the patients were in the age group of 21 to 30 yrs.

There was a male (85%) predominance in this study.

Fall from height (65%) is the most common mode of injury.

55% of patients presented with in 24 hrs of injury.

25% of patients had no neurological deficit.

C5 over C6 subluxation with facetal locking (10 cases) was the most common spinal injury encountered.

Mean duration of fusion was 6 months.

Mean blood loss was 150 ml.

Complications:

Wound dehiscence: 1 case – conservative

Loss of reduction : 2 cases- conservative

Radiculopathy : 1 case - conservative

Post operative Frankel grading:

- D – 11 cases
- E – 9 cases

ANALYSIS OF RESULTS

Results were analysed during follow up using following criteria:

1) Pain
2) Neurological recovery
3) Fusion status
4) Stability of spine

The neurological status was assessed using Frankel grading.

Type	***Characteristics***
A	Absent motor & sensory function
B	Sensation present & motor absent
C	Sensation present & motor active but not useful grade i.e., $<3/5$
D	Sensation present & motor active but useful grade i.e., $\geq 3/5$
E	Normal motor and sensory function

The results are graded as follows (Roy-Camille & Levine–1992)

Good:

- No neck pain
- Clear fusion mass at desired level
- Good stability of spine on stress X-rays
- Complete or partial neurological recovery

Fair:

- Moderate neck pain which does not restrict day to day activities.
- No recovery of neurological deficit
- Poor fusion mass
- Good stability of spine.

Poor:

- Severe neck pain
- No recovery or worsening of neurological deficit
- Pseudarthrosis
- Unstable spine

RESULTS

- Pain was absent in all cases
- Neurologic recovery noticed in most cases
- No neurologic detorioration
- Fusion achieved in all cases
- Stabiliity of spine is good in all cases
- So, the grading of results is GOOD in all cases.

RESULTS

Eighty lateral mass screws placed by using Roy-camille technique. The mean follow up was 19 months ranging from 28 to 4 months. 75% of patients had at least 18 month of follow up. All patients showed improved neurological status according to Frankel grading

50% (10) of patients showed improvement of two Frankel grading. All patients with intact neurology showed no further neurological deterioration. Four patients showed improvement in one Frankel grading. And three patients showed complete recovery. Good recovery shown by patients from Frankel grading C. we found poor recovery is seen in C7, C8, and TI involvement which supplies small muscles of the hand.

In this study we showed 95% of patients showed solid fusion.

Loss of reduction seen in two patients due to poor compliance they started early mobilization of the neck. But solid fusion noticed in these patients and no further deterioration.

Bowel and bladder recovery are seen in all 15 incomplete neurologically deficit patients.

Neck movements restriction seen in who were all stabilized at cervico dorsal junction.

Anterior disc space narrowing is seen in ten patients after one year of follow up.

As a complication of screw technique we found to have one patient developed C5 radiculopathy. In this study no screw pull out, screw breakage, plate breakage seen. We concluded that both right and left oblique views are enough to rule out screws in neural foramina. CT scan is not mandatory.

In this study one patient developed superficial skin infection, wound healed secondarily.

We found development of kyphosis is seen in two patients in whom loss of reduction seen.

DISCUSSION

Posterior cervical plates with lateral mass fixation are currently used for posterior internal fixation of the lower cervical spine. This technique of internal fixation has been proved to restore the stability of the cervical motion segment after traumatic or postlaminectomy injuries. Since Roy-Camille et al described the technique for the first time in 1972; many authors have described technical variations to improve the mechanical competence or the anatomic safety.

The anatomic structures at risk during lateral mass screw placement of the cervical spine are the nerve roots, the vertebral artery, and the adjacent lateral masses. A spinal cord injury during plate-screw fixation has never been reported in the literature. Contrary to the lumbar spine, the cervical nerve root is placed at the lower part of the intervertebral foramen. Inside the intervertebral foramen the course of the nerve root is oblique anteriorly, laterally, and inferiorly running inside a groove on the ventral aspect of the lateral mass just behind the vertebral artery. At the lateral part of the intervertebral foramen, nerve root divides in two branches. The dorsal ramus placed posteriorly and superiorly runs against the anterolateral corner of the base of the superior articular process just above the posterior ridge of the transverse process. The ventral root placed ventrally and inferiorly continues the nerve root direction inside a groove formed by the two branches of the transverse process.

In our study a total of 80 lateral mass screws are placed into the lateral masses of the cervical spine in twenty patients using Roy-camille technique. The mean follow up was 19 months ranging from 28 months to 4 months. To compare Ebraheim and Quaiser et al (2005)[31] a total of 328 screws were placed into the lateral masses of the cervical spine in 67 patients using Roy-Camille technique. The mean follow-up was 27.8 months ranging from 13 to 75 months. More than 85% enrolled patients had at least 22 months of follow-up. To compare with Graham and Swank et al (1996) a prospective study evaluating screw position and associated complications in 21 consecutive patients treated with a plate and screw fixation system applied to the lateral masses of the cervical spine revealed 100% fusion and 1.8% of screw breakage.

Cooper and Cohen et al (1988)[2] presented a series of 20 patients of traumatic cervical spine instability; successful fusion was obtained in 95%with one failure of instrumentation.

Grady and Anderson et al (1994)[1] reported their results of 102 patients with traumatic cervical spine injuries; all patients achieved fusion.

The series of Heller and Silcox et al (1995)[15] of 79 patients identified the following complications of posterior plating; broken screws-0.1%, broken plate-1.3%, lost reduction- 2.5%, pseudarthrosis-2%, adjacent segment degeneration-5%, nerve injury-0.6%.

In this study all patients maintained or improved their neurological status. Fifteen out of fifteen patients (100%) with incomplete spinal cord injuries had an improvement of at least one Frankel grade. This study achieved a 95% fusion rate, at an average of 6 months. A solid fusion was determined by lateral radiographs, which showed formation of bone or trabeculae across the facet joints. None of the patients required supplemental anterior or posterior surgery. This is comparable with Ebraheim and Quaiser et al (2005)[31] they shown at least one Frankel grade in 90% of patients and mean time for fusion was also 6 months. Anderson PA et al (1991)[1] supports the bone grafting for fusion.

Levine and Roy-Camille et al (1992)[6] noted that 6 out of 24 patients developed radicular symptoms following posterior lateral mass screw fixation. Heller et al (1995)[15] reviewed 79 consecutive patients who underwent posterior lateral mass plating and reported an incidence of 0.6% for nerve injury. Graham and Swank et al (1996)[16] reported a higher incidence (14%) of nerve root injury associated with lateral mass screw fixation in 21 patients. In our study one patient (.0125%) developed radiculopathy out of twenty patients. There was a 1.8%-per-screw risk of radiculopathy in Graham and Swank et al (1996)[16] study. In our department the previous study (2003) of ten patients did not show any root involvement. Nerve root compromise has been attributed to placement of excessively long screws, Ebraheim and Quaiser et al (2005)[31] 328 screws utilizing Roy-Camille technique were safely placed into the lateral masses of the cervical spine in 67 patients without any neurological complications.

Several recommendations have been made for the ideal starting point and placement angle of the lateral mass screw. All strive to achieve maximum safety and optimize biomechanical effectiveness. Most are variations from the two earliest methods taught by Magerl and Roy-Camille. The Magerl technique dictates a screw trajectory of 45[degrees] cephalad in the sagittal plane (relative to the vertebral body's endplate) and 25[degrees] lateral in the axial plane. According to An et al (1991)(17) and Heller et al (1995)(17) directing the screw tip to the most superior portion of the lateral mass places the root at greater risk but improves fixation by increasing the excursion of the screw in bone. The Roy-Camille technique prescribes a screw trajectory of 0[degrees] in the sagittal plane and 10[degrees] laterally in the axial plane. The theoretical advantage of the Roy-Camille technique is less risk to the nerve root. Both techniques dictate lateral angulations of the screw, lessening the risk of nerve root and vertebral artery injury.

To analyze screw position in lateral view by using Ebrahiem zonal classification none of the screws in our study crosses the zone 1, (Ebraheim, and Tremains et al, (1998)(19). The screw length is proper and safer if the tip of a screw placed by the Roy-Camille technique is located in Zone I. It was also noted that the screw length can be determined more accurately on lateral radiographs in screws placed using the Roy-Camille technique than other techniques. The lateral radiographs may be valuable in evaluation lateral mass screw placement in the cervical spine.

Findings by Lali et al (2005)[32] shows lateral mass fixation using Roy-camille technique is most effective method of posterior cervical spine stabilization in various cervical pathologies including trauma. He found that in most cases, 14mm into3.5mm cortical screws offers adequate stability and zero% risk of neurovascular injury.

Screw loosening is a feature of biomechanical failure in any types of fixation. We don't have come across about this complication. This complication was reported by Lali et al (2005)[32] in his study found in 0.6% of patients. 6% screw pull out seen in a study by Anderson et al, (1991) [32].

Smith and Langrana et al (1997) [14] found that Roy-Camille posterior cervical spine fixation plates provided stiffness equal to or greater than that of an intact spine. Failure always resulted from screw pull-out at predictable levels of force. Plates and screws did not show any material failure. There was no significant difference between titanium and stainless steel Roy-Camille fixation systems. This is because screw pull-out occurred before the plate stiffness differences came into play.

Screw breakage occurring in lateral mass fixation was seen in the following studies. Lali et al (2005)[32] in his study he found in 0.4% of patients, Ebraheim et al (2005)[32] found it was 0.5%, McAfee and Sutterlin et al (1998)[10] found it was 5%. In our study there is no screw breakage found.

In our study we had two patients with loss of reduction. This was due to shorter screws. But these patients had good solid bony fusion and no neurological deterioration.

Superficial wound infection was seen in a patient was treated with antibiotics according to culture sensitivity.

Good recovery shown by patients from Frankel grading C. Recovery of hand muscles innervated by C7 C8 T1 shows poor recovery. Bowel and bladder recovery are seen in all 15 incomplete neurologically deficit patients.

This study don't find restriction of neck movements except restriction seen in who were all stabilized at cervico-dorsal junction.

No foramina encroachment by screws found.

Anterior disc space narrowing is seen in ten patients after one year of follow up. Development of kyphosis is seen in two patients in whom loss of reduction seen.

COMPARING WITH LITEATURE

	Ebrahiem (2005)[31]	***Lali (2005)***[32]	***Cooper (1988)***[2]	***Heller (1995)***[15]	***This study***
Fusion	100%	100%	95%	95%	95%
Screw Pullout	–	6%	–	–	–
Screw Breakage	1.8%	0.4%	–	0.1%	–
Implant Failure	–	–	5%	1.3%	–
Loss of reduction	–	–	–	2.5%	10%
Infection	–	–	–	–	0.5%
Nerve Injury	–	0.6%	–	0.6%	0.125%

In summary, our study of 20 patients with traumatic cervical spine shows 95% 0f fusion, two loss of reduction, one patient with unilateral radiculopathy with no screw breakage and instrumentation failure. The results are comparable with literature results. The current study indicates that posterior lateral mass plate-screw fixation using the Roy-Camille technique is a safe procedure for traumatic instability of the lower cervical spine with a higher fusion rate and no neurological complications. To achieve a satisfactory outcome, a solid anatomic and radiological knowledge of the lateral mass and adjacent vital structures and meticulous surgical technique are required.

CONCLUSIONS

Lateral mass fixation by using Roy-camille technique provide adequate fixation for most patterns of cervical instability

Roy-camille technique is the safest technique with least incidence of injury to the nerve root and vertebral artery

Roy-camille technique offers better biomechanical stability to the traumatic lower cervical spinal injury.

Lateral mass fixation with plates and screws should have supplement of bone grafting for better biomechanical stability

In properly selected patients, Lateral mass fixation by using Roy-camille technique doesn't require additional anterior stabilization.

Roy-camille technique doesn't require any special instruments.

Patient can be moblilsed early with minimal external orthrosis after the surgery with minimal complications

A simple, easy and cost effective procedure permits early mobilization and prevents complications with out any neurological complications.

ILLUSTRATIVE CASES

CASE NO: 1

Name	:	Mohamed idayathulla
Age/sex	:	19years/male
Date of admission	:	5.5.2006
In patient number	:	805584
Date of Surgery	:	14.6. 2006
Mode of injury	:	Fall from height
Diagnosis	:	C6 over C7 subluxation with Quadriparesis
Pre op Frankel grade	:	C
Procedure done	:	Lateral mass fixation & fusion
Follow up	:	27 month follow up showed good Fusion and stability
Post op Frankel grade	:	E
Results	:	Good

ILLUSTRATIVE CASES

CASE NO: 2

Name	:	Manikandan
Age/sex	:	42years/male
Mode of injury	:	RTA
Date of admission	:	28.11.2006
In patient number	:	855493
Date of Surgery	:	20.12. 2006
Diagnosis	:	C5 over C6 subluxation with Quadriparesis
Pre op Frankel grade	:	C
Procedure done	:	Lateral mass fixation & fusion
Follow up	:	19 month follow up showed good Fusion and stability
Post op Frankel grade	:	E
Results	:	Good

ILLUSTRATIVE CASES

CASE NO: 3

Name	:	Valli
Age/sex	:	20years/Female
Mode of injury	:	Fall from 10 feet height
Date of admission	:	22.1.2007
In patient number	:	4467
Date of Surgery	:	28.2. 2007
Diagnosis	:	C5 over C6 subluxation with out Neurological deficit
Pre op Frankel grade	:	E
Procedure done	:	Lateral mass fixation & fusion
Follow up	:	17 month follow up showed good Fusion and stability
Post op Frankel grade	:	E
Results	:	Good

ILLUSTRATIVE CASES

CASE NO: 4

Name	:	Appavu
Age/sex	:	35years/male
Mode of injury	:	Heavy object fall over the neck
Date of admission	:	16.2.2007
In patient number	:	10885
Date of Surgery	:	7.3. 2007
Diagnosis	:	C4 over C5 subluxation with Quadriparesis
Pre op Frankel grade	:	C
Procedure done	:	Lateral mass fixation & fusion
Follow up	:	18 month follow up showed good Fusion and stability
Post op Frankel grade	:	E
Results	:	Good

ILLUSTRATIVE CASES

CASE NO: 5

Name	:	Manickam
Age/sex	:	35years/Female
Mode of injury	:	RTA
Date of admission	:	5.1.2008
In patient number	:	1175
Date of Surgery	:	14.1. 2008
Diagnosis	:	C3 over C4 subluxation with out Neurological deficit
Pre op Frankel grade	:	E
Procedure done	:	Lateral mass fixation & fusion
Follow up	:	8 month follow up showed good Fusion and stability
Post op Frankel grade	:	E
Results	:	Good

BIBLIOGRAPHY

1. Anderson P A, Henley MB, Grady MS, et al. Posterior cervical arthrodesis with AO reconstruction plates and bone graft. Spine. 1991; 16:S72- 79.

2. Cooper PR, Cohen AF, Rosiello A, et al. Posterior stabilization of cervical spine fractures and subluxation using plates and screws. J Neurosurg. 1988; 23:300-306.

3. Ebraheim NA, An HS, Jackson WT, et al. Internal fixation of the unstable cervical spine using posterior Roy-Camille plates: a preliminary report. J Orthop Trauma. 1989; 3 :23-28.

4. Fehlings MG, Cooper PR, Errico TJ. Posterior plates in the management of cervical instability: long-term results in 44 patients. J Neurosurg. 1994; 81 :341-349.

5. Jeanneret B, Magerl F, Ward EH, et al. Posterior stabilization of the cervical spine with hook plates. Spine. 1991; 16:S56-S63.

6. Levine AM, Maze1 C, Roy-Camille R. Management of fracture separations of the articular mass using posterior cervical plating. Spine. 1992; 17:S447-S454.

7. Nazarian SM, Louis RP. Posterior internal fixation with screw plates in traumatic lesions of the cervical spine. Spine. 1991; 16:S64-S71.

8. Roy-Camille R, Saillant G, Lavile C, et al. Treatment of lower cervical spinal injuries C3 to C7. Spine. 1992; 17:S442-S446.

9. Roy-Camille R, Saillant G, Mazel C. Internal fixation of the unstable cervical spine by a posterior osteosynthesis with plate and screw. In: Sherk HM, ed. The Cervical Spine. Philadelphia, PA: Lippincott; 1989: 390-403.

10. Sutterlin CE, McAfee PC, Warden KE, et al. A biomechanical evaluation of cervical spinal stabilization methods in a bovine model. Spine. 1988; 13:795-802.

11. Coe JD, Warden KE, Sutterlin CE, et al. Biomechanical evaluation of cervical spine stabilization methods in a human cadaveric model. Spine. 1989; 14: 1122-1131.

12. Gill K, Paschal S, Corin J, et al. Posterior plating of the cervical spine: a biomechanical comparison of different posterior fusion techniques. Spine. 1988;13:813816.

13. Kotani Y, Cunningham RW, Abumi K, et al. Biomechanical analysis of cervical stabilization systems. Spine. 1994; 19:2529-2539.

14. Smith ME, Cibischino M, Langrana NA, et al. A biomechanical study of a cervical spine stabilization device: Roy-Camille plates. Spine. 1997; 22:38-43.

15. Heller JG, Silcox H, Sutterlin CE. Complications of posterior cervical plating. Spine. 1995; 20:2442-2448.

16. Graham AW, Swank ML, Kinard RE, et al. Posterior cervical arthrodesis and stabilization with a la_eral mass plate: Clinical and computed tomographic evaluation of

lateral mass screw placement and associated complications. Spine. 1996; 21:323-329.

17. An H, Gordin R, Renner K. Anatomic considerations for plate-screw fixation of the cervical spine. Spine. 1991; 16:8548-551.

18. Ebraheim NA, Xu R, Challgren E, et al. Quantitative anatomy of the cervical facet and the posterior projection of its inferior facet. J Spinal Disorders. 1997; 10:308-316.

19. Ebraheim NA, Tremains MR, Xu R, et al. Lateral radiologic evaluation of lateral mass screw placement in the cervical spine. Spine. 1998; 23(4): 458-62.

20. Ebraheim NA, Haman SH, Xu R, et al. The anatomic location of the dorsal ramus of the cervical nerve and its relation to the superior articular process of the lateral mass. Spine. 1998; 23(18): 1968-71.

21. Ebraheim NA, Xu R, Yeasting RA. The location of the vertebral artery foramen and its relationship to posterior lateral mass screw fixation. Spine. 1996; 21: 1291-1295.

22. Wellman BJ, Follett KA, Traynelis VC. Complications of posterior articular mass plate fixation of the subaxial cervical spine in 43 consecutive patients. Spine. 1998; 23:193-200.

23. Xu R, Robke J, Ebraheim NA, et al. Evaluation of cervical posterior lateral mass screw placement by oblique radiographs. Spine. 1996; 21 :696-701.

24. Ebraheim NA, Xu R, Challgren E. Radiologic evaluation of the relation of the screw tip to the nerve root in the intervertebral foramen. J Spinal Disorders. 1997; 10:234-239.

25. Ebraheim NA, Xu R, Stanescu S, Yeasting RA. Anatomic relationship of the cervical nerves to the lateral masses. Am J Orthop. 1999 Jan;28(1):39-42.

26. Ebraheim NA, Klausner T, Xu R, Yeasting RA. Safe lateral-mass screw lengths in the Roy-Camille and Magerl techniques. An anatomic study. Spine. 1998 Aug 15;23(16):1739-42.

27. Ebraheim NA, Rupp RE, Savolaine ER, Brown JA. Posterior plating of the cervical spine. J Spinal Disord. 1995 Apr;8(2):111-5.

28. Muffoletto AJ, Yang J, Vadhva M, Hadjipavlou AG. Cervical stability with lateral mass plating: unicortical versus bicortical screw purchase. Spine. 2003 Apr 15;28(8):778-81.

29. Papagelopoulos PJ, Currier BL, Neale PG, Hokari Y, Berglund LJ, Larson DR, Fisher DR, An KN. Biomechanical evaluation of posterior screw fixation in cadaveric cervical spines. Clin Orthop Relat Res. 2003 Jun;(411):13-24.

30. Seybold EA, Baker JA, Criscitiello AA, Ordway NR, Park CK, Connolly PJ. Characteristics of unicortical and

bicortical lateral mass screws in the cervical spine. Spine. 1999 Nov 15;24(22):2397-403.

31. Ebraheim NA, Qaiser Shafiq,Rong Ming Xu, F A Al-Hamdan. Roy – Camille Technique for Traumatic Instability of the Lower cervical spine. The Internet Journal of Spine Surgery, 2005, vol 2, number 1.

32 Lali H.S. Sekhon, Posterior cervical spine lateral mass fixation – Analysis of 1026 consecutive screws in 143 patients. Journal spinal disord Tech 2005, vol 00, number 0, 2005

33 Gray Anatomy

34 Rock wood green, cervical spine injuries.

INSTITUTIONAL ETHICAL COMMITTEE
GOVERNMENT GENERAL HOSPITAL & MADRAS MEDICAL COLLEGE,
CHENNAI-600 003.

21

Telephone: 044-2530 5000
Fax : 044 – 25305115

K.Dis.No.43781P & D3/Ethies/Dean/GGH/08 Dated: 24/11/2008

Title of the work : "Roy – camille Technique for lateral mass Plate Fixation in cervical spine facet joint dislocation – A short team outcome Analysis"

Principal Investigator : Dr. A.P. Siva kumar, PG in MS.

Department : orthopaedics, MMC & GGH Ch.3.

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 25.11.2005 at 2 P.M in Government General Hospital, Deans, Chamber, Chennai-3.

The members of the Committee, the Secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The principal investigator and their term are directed to adhere the guidelines given below:

1. You should get detailed informed consent from the patients/participants and maintain confidentiality.
2. You should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution or Government.
3. You should inform the IEC in case of any change of study procedure, site and investigation or guide.
4. You should not deviate form the area of the work for which I applied for ethical clearance.
5. You should inform the IEC immediately, in case of any adverse events or serious adverse reactions.
6. You should abide to the rules and regulations of the institution(s)
7. You should complete the work within the specific period and if any extension of time is required, you should apply for permission again and do the work.
8. You should submit the summary of the work to the ethical committee on completion of the work.
9. You should not claim funds from the Institution while doing the work or on completion.
10. You should understand that the members of IEC have the right to monitor the work with prior intimation.

12/12

SECRETARY	CHAIRMAN	DEAN
IEC, GGH,CHENNAI	IEC, GGH,CHENNAI	GGH &MMC, CHENNAI

Rkm.5.9(2)

MASTER CHART

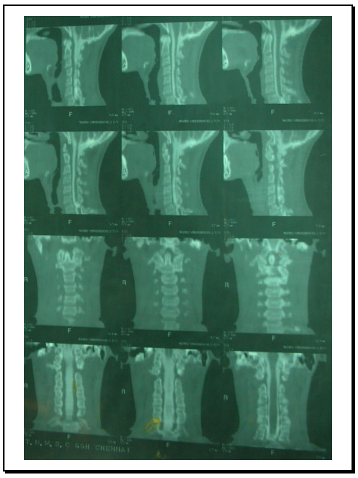
S.No	Name	Age / Sex	IP No	Mode of Inj	Diagnosis	Date of Surgery	Complication	Fusion	Pre-op Frankle	Post-op Frankle	Follow up	Results
1.	Suthakar	26M	804605	RTA	C4 over C5 sublux Q.plegia	26.05.05	Nil	+	B	D	22.1.07 19.9.08 (28 months)	Good
2.	Md.Sum Idayathulla	19M	805584	Fall	C6 over C7 Q.paresis	14.06.06	Nil	+	C	E	29.9.08 (27mths)	Good
3.	Shankaraj	48M	814885	RTA	C4 over C5 sublux Q.paresis	23.06.05	Nil	+	B	D	19.1.07 21.9.08 (27 mths)	Good
4.	Rangan	29M	816127	Fall	C5,C6 sublux Q.paresis	14.07.06	Nil	+	C	D	19.1.07 19.9.08 (26 mths)	Good
5.	Ambika	24F	828858	Fall (10ft)	C4 over C5 sublux Q.paresis	06.09.06	Nil	+	B	D	16.10.06 1.10.08 (2 yrs)	Good
6.	Dhanasekar	25M	831612	Fall	C4 over C5 Q.paresis	25.08.06	Nil	+	C	D	12.3.07 19.9.08 (25 mths)	Good
7.	Manikandan	42M	855493	RTA	C5, C6 sub	20.12.06	Nil	+	C	E	12.3.07 19.9.08	Good

S.No	***Name***	***Age / Sex***	***IP No***	***Mode of Inj***	***Diagnosis***	***Date of Surgery***	***Complication***	***Fusion***	***Pre-op Frankle***	***Post-op Frankle***	***Follow up***	***Results***
					Q.paresis						(21 mths)	
8.	Ilanchezhian	40M	856997	Fall	C7 Body # Q.paresis	10.1.07	Nil	+	B	D	29.09.08 (21 mths)	Good
9.	Manimaran	43M	1165	Fall of heavy object over the neck	C5 C6 sublux without deficit	21.02.07	Nil	+	E	E	19.3.07 19.9.08 (19 mths)	Good
10.	Valli	20F	4467	Fall	C5C6 sublux without deficit	28.02.07	Nil	+	E	E	6.6.07 29.9.08 (17 mths)	Good
11.	Munianadi	55M	48263	Fall from height	C5, C6 sublux Q.paresis	6.08.07	Nil	+	C	D	28.9.08 (13 mths)	Good
12.	Appavu	35M	10885	Fall of wt. over the neck	C4 over C5 sublux Q.paresis	7.3.07	Nil	+	C	E	16.4.07, 11.6.07, 18.9.06 (18 mths)	Good
13.	Bhavani shankar	34M	10898	Fall from high	C5, C6 sublux without	23.3.07	Nil	+	E	E	30.4.07 19.9.08 (18 mths)	Good

S.No	Name	Age / Sex	IP No	Mode of Inj	Diagnosis	Date of Surgery	Complication	Fusion	Pre-op Frankle	Post-op Frankle	Follow up	Results
					deficit							
14.	Saravanan	25M	34450	Fall	C5, C6 sublux without deficit	7.6.07	Superficial wound infection 2^{o} healing	+	E	E	16.10.07, 28.09.08 (15 mths)	Good
15.	Krishnamoorthy	31M	36418	Fall	C5 over C6 sublux Q.paresis	18.06.07	Loss of reduction	+	C	D	4.8.07, 6.11.07, 28.9.08 (15 mths)	Good
16.	Vedagiri	47M	47874	Fall	C5 over C6 sublux Q.paresis	25.8.07	Nil	+	D	E	23.10.07, 25.9.08 (16 mths)	Good
17.	Manickam	35F	1175	RTA	C3,C4 sublux without deficit	14.1.08	Loss of reduction	+	E	E	8.3.08, 20.9.08 (9mths)	Good
18.	Viyapuri	54M	10894	Fall	C5, C6 sublux Q.paresis	25.03.08	Nil	+	B	D	17.7.08 (4 mths)	Good
19.	Duraikannan	60M	21478	Fall	C5, C6 sublux Q.paresis	31.03.08	Nil	+	B	D	14.06.08, 4.10.08 (6mths)	Good

S.No	***Name***	***Age / Sex***	***IP No***	***Mode of Inj***	***Diagnosis***	***Date of Surgery***	***Complication***	***Fusion***	***Pre-op Frankle***	***Post-op Frankle***	***Follow up***	***Results***
20.	Suresh	25M	27480	Fall	C7, # Q.paresis	22.5.08	Nil	Nil	B	D	1.10.08 (4mths)	Good

ILLUSTRATIVE CASE - I

PRE-OP LATERAL PRE-OP AP PRE-OP CT

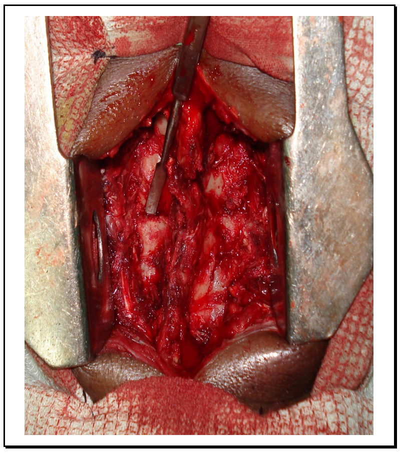
28 MONTHS FOLLOW UP

28 MONTHS FOLLOW UP CLINICAL

ILLUSTRATIVE CASE - II

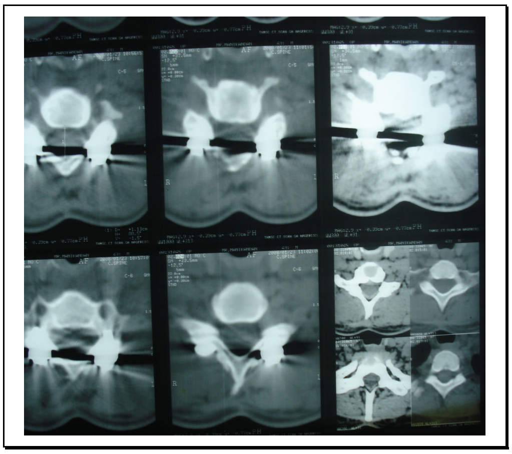




PRE-OP AP VIEW PRE-OP LATERAL PER - OP



21 MONTHS FOLLOW UP



POST-OP CT POST-OP CLINICAL

ILLUSTRATIVE CASE - III

PRE-OP LATERAL PRE-OP AP POST-OP LATERAL (17 M)

17 MONTHS POST-OP FOLLOW UP



17 MONTHS POST-OP FOLLOW UP CLINICAL

ILLUSTRATIVE CASE - IV



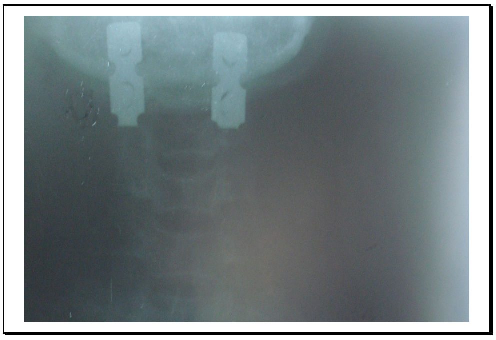
PRE-OP AP PRE-OP LATERAL POST-OP LATERAL (18M)

18 MONTHS POST-OP FOLLOW UP

18 MONTHS POST-OP FOLLOW UP CLINICAL

ILLUSTRATIVE CASE - V

PRE-OP AP PRE-OP LATERAL IMMEDIATE POST-OP

9 MONTHS FOLLOW UP



9 MONTHS FOLLOW UP CLINICAL

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

MOTOR

KEY MUSCLES

	R	L	
C2			
C3			
C4			
C5			Elbow flexors
C6			Wrist extensors
C7			Elbow extensors
C8			Finger flexors (distal phalanx of middle finger)
T1			Finger abductors (little finger)
T2			
T3			
T4			
T5			
T6			
T7			
T8			
T9			
T10			
T11			
T12			
L1			
L2			Hip flexors
L3			Knee extensors
L4			Ankle dorsiflexors
L5			Long toe extensors
S1			Ankle plantar flexors
S2			
S3			
S4-5			

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
NT = not testable

Voluntary anal contraction (Yes/No)

TOTALS ☐ + ☐ = ☐ MOTOR SCORE

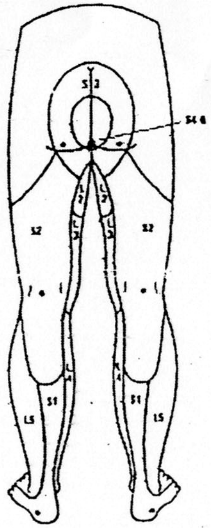
(MAXIMUM) (50) (50) (100)

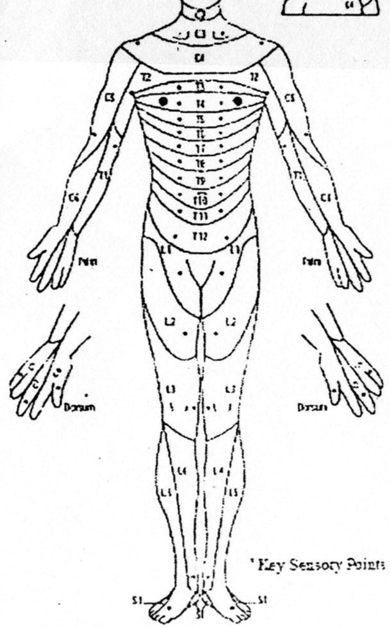
SENSORY

KEY SENSORY POINTS

	LIGHT TOUCH R	LIGHT TOUCH L	PIN PRICK R	PIN PRICK L
C2				
C3				
C4				
C5				
C6				
C7				
C8				
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
T10				
T11				
T12				
L1				
L2				
L3				
L4				
L5				
S1				
S2				
S3				
S4-5				

0 = absent
1 = impaired
2 = normal
NT = not testable





* Key Sensory Points

Any anal sensation (Yes/No)

TOTALS ☐ + ☐ = ☐ PIN PRICK SCORE (max: 112)

☐ + ☐ = ☐ LIGHT TOUCH SCORE (max: 112)

(MAXIMUM) (56) (56) (56) (56)

NEUROLOGICAL LEVEL

The most caudal segment with normal function

	R	L
SENSORY		
MOTOR		

COMPLETE OR INCOMPLETE? ☐

Incomplete = Any sensory or motor function in S4-S5

ASIA IMPAIRMENT SCALE ☐

ZONE OF PARTIAL PRESERVATION

Caudal extent of partially innervated segments

	R	L
SENSORY		
MOTOR		